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Ms Jane Moynihan
Executive Director
Queensland Floods Commission of Inquiry
400 George Street
Brisbane
QLD 4000

Dear Ms Moynihan,

SUBJECT: PRELIMINARY FINDINGS OF PEER REVIEW - REPORT ON BRISBANE RIVER FLOOD FREQUENCY ANALYSIS PREPARED BY MARK BABISTER AND MONIQUE RETALLIK

1 BACKGROUND

Mark Babister and Monique Retallick (WMAwater) have prepared a report for the Queensland Floods Commission of Inquiry (QFCI) entitled '*Brisbane River 2011 Flood Event – Flood Frequency Analysis*' dated 18th September 2011. The report estimates the average recurrence interval (ARI) of the January 2011 flood and the 100 year ARI (1% AEP) flood discharge in the lower reaches of the Brisbane River (downstream of the Bremer River junction). In addition, based on its 100 year ARI discharge estimate, the report estimates 100 year ARI flood levels along the lower reaches of the Brisbane River and compares them with the 100 year ARI flood levels currently adopted by the Brisbane City Council.

DLA Piper Australia, acting on behalf of the Insurance Council of Australia (ICA), requested WRM Water & Environment Pty Ltd (WRM) to undertake a review of the WMAwater report for the purpose of assisting the commission. This report is in response to that request.

2 SCOPE OF WORK

This review has been undertaken on the basis of information and data gathered from a desktop review of the WMAwater report and supporting documentation provided by QFCI.

No independent hydrologic or hydraulic modelling has been undertaken by WRM as part of this review. Further, due to the limited time that was available to undertake this review, the findings of this report should be considered as preliminary.

The WMAwater report provided to WRM does not address Bremer River flooding in the vicinity of Ipswich as required under the scope of work specified by QFCI. WMAwater has since prepared a supplementary report on the Bremer River flooding dated 12th October 2011 but WMAwater's supplementary report has not been reviewed as part of this review by WRM due to time constraints.

3 GENERAL FINDINGS

3.1 Methodology

In my opinion, the analyses presented in the WMAwater report are not sufficiently rigorous to accurately estimate the ARI of the January 2011 flood or estimate the 100 year ARI flood discharges or levels in the lower reaches of the Brisbane River, especially for current (with Wivenhoe and Somerset dams) river conditions. It is possible that the limited time available for the study did not allow a rigorous investigation.

The methodology adopted for the pre-dam conditions flood frequency analyses (FFA) is generally acceptable (with some reservations) but the methodology adopted for the current post-dam conditions (with Wivenhoe and Somerset dams), in my view, is not satisfactory.

The key assumptions made, data used and data adjustments made in the FFA are not adequately explained or justified in the WMAwater report. Further, the level of detail presented on the FFA that has been undertaken and the results obtained from the FFA are inadequate to assess the validity of the results presented in the WMAwater report. In addition, the method used to correlate pre and post dams discharges at the Brisbane Port Office gauge is too simplistic and, in my view, should not be used.

The hydraulic model used to predict the 100 year ARI flood profile is acceptable but more accurate predictions could be made using a 2-Dimensional hydraulic model. There is insufficient information in the WMAwater report to assess whether the boundary conditions used in the hydraulic model to predict the 100 year ARI flood profile are acceptable.

3.2 Results Validation

The FFA has focussed solely on data at the Brisbane Port Office gauge. Although the Port Office gauge has the longest historical record, there are considerable uncertainties associated with this data set and, as a consequence, the results obtained using this data are also uncertain. The WMAwater report identifies the key limitations, difficulties and uncertainties associated with the Port Office data set. However, it has made no attempt to minimise the impact of these limitations and uncertainties by cross-checking and correlating the validity of Port Office gauge data and results against data and results for other lower Brisbane River gauge sites with long data records such as Mt Crosby, Moggill and Savages Crossing. Regional flood frequency analyses could have also been used to validate the results of the study. Sensitivity analyses to assess the impact of some of the uncertainties have not been undertaken.

The WMAwater study has undertaken a FFA of only the peak annual flood discharges in the Lower Brisbane River. A comprehensive FFA should also include an assessment of the peak annual flood event volumes particularly due to the flood storage affects of Wivenhoe and Somerset dams.

3.3 Inconsistencies and Potential Errors

There are significant uncertainties in the FFA results presented in the WMAwater report, including potential errors in the 100 ARI discharge estimate. These are discussed in Section 4.

There are also some apparent inconsistencies in the estimation of the 100 year ARI flood profile. These are discussed in Section 5.

3.4 Other Factors

The likely changes in the future to the Wivenhoe Dam and Somerset Dam operating rules may lower the 100 year ARI flood discharge in the lower Brisbane River. This potential impact may have to be considered when determining future 100 year ARI discharges and assessing the predicted 100 year ARI flood profiles.

4 FINDINGS ON FLOOD FREQUENCY ANALYSES AND RESULTS

4.1 General

The WMAwater report provides only very limited results on the FFA analyses. No statistics are given to assess how well the data fits the two probability distributions used to derive flood ARI's. Further, no FFA plots are given for the analyses that exclude the January 2011 flood.

4.2 Adopted Data and Analyses

In the FFA, the recorded peak flood levels for all pre-1917 floods, including the 1841 and 1893 floods, have been lowered by 1.52m to account for the effects of river dredging undertaken prior to 1917. Based on an assessment of continuous data from 1891 for the Port Office and Moggill gauges, SKM (1999) found that the 1841 and 1893 flood peaks at the Port Office were unaffected by river dredging and that the 1.52m adjustment should not be applied to large floods such as 1841 and 1893. The large floods generally have a significant influence on 100 year ARI estimates. The 1841 and 1893 floods were the largest and second largest floods on record. Hence, the FFA results, including the 100 year ARI flood discharge estimate, could potentially change significantly if the above adjustment to 1841 and 1893 recorded flood levels is removed from the analysis.

A new rating curve derived in the study (see Figure 8 of the WMAwater report) has been adopted for the Port Office gauge to convert recorded peak flood levels into peak discharges for use in the FFA. There are some uncertainties with this new rating curve. For example, the recorded peak flood level at the Port Office gauge for the January 2011 flood does not fit the derived rating curve. In addition, based on the shape of the January 2011 recorded water level hydrograph, the tidal influence appears to have affected flood levels at the Port Office gauge at least up to discharges of 9,500 m^3/s (Seqwater, 2011). Tidal influences are not taken into account in the adopted rating curve.

It appears that the flood events greater than 2,000 m^3/s have been classified as large and the remainder as small for the purposes of the FFA. The basis/justification for the selection of this threshold value is not known. Given that tidal influences affect flood levels for much higher discharges the adoption of a 2,000 m^3/s threshold appears unjustified. The adopted flood threshold has resulted in 141 out of 171 values

(82.5%) and 90 out of 102 values (88%) being 'censored' for the 171 year (1841-2011) and 102 year (1908-2011) data sets respectively. It is not clear what 'censored' means but it appears that these values have been omitted from the analysis. The recorded discharges at the upstream gauges should have been used to derive a discharge data set at the Port Office.

The February 1999 flood upstream of Wivenhoe and Somerset dams was larger than the 1974 flood (Seqwater, 2011). Based on data presented in Appendix B of the WMAwater report, it appears that the 1999 flood is not appropriately taken into account in the pre dams FFA.

4.3 Results

The following is of note with respect to the results for pre-dams conditions:

- The WMAwater report concludes that the 100 year ARI flood discharge at the Port Office estimated from the FFA is not sensitive to whether the January 2011 event is included or not. There is insufficient information in the WMAwater report to justify this finding.
- There is consistency in the pre-dam GEV distribution results for the two data periods analysed and for the two cases with and without the inclusion of the January 2011 flood. The results for the LP3 distribution for the shorter data set with and without the inclusion of the January 2011 flood are also consistent. However, the LP3 results for the longer data set with and without the inclusion of the January 2011 flood are not consistent. The reasons for this inconsistency are not discussed in the WMAwater report.
- The January 2011 flood ARI at the Port Office gauge for pre-dam conditions has been estimated to be 100 years. The estimated January 2011 peak flood discharge at the Port Office gauge for pre-dam conditions is 12,400 m^3/s. This finding is within an acceptable range for the data used in the analyses. However, based on the apparent better fit of the data for the LP3 distribution results, the ARI of the January flood for pre-dam conditions should be somewhat less than 100 years. It is also noted that if no river dredging adjustment had been applied to the 1841 and 1893 data the results may change significantly. These issues highlight the uncertainties associated with the results presented in the WMAwater report.
- The ARI's estimated from the FFA results are significantly higher than the likely probabilities estimated from plotting positions (see Table 9 of the WMAwater report). The reason for this is not discussed in the WMAwater report.

The following is of note with respect to the results for current (with-dams) conditions:

- It appears that no FFA has been undertaken for the current river conditions (with Wivenhoe and Somerset dams). Yet, an ARI for the January 2011 flood and a 100 year ARI discharge have been estimated for current river conditions. The basis for these estimates or justification for the adopted values is not adequately discussed in the WMAwater report.
- There is a heavy reliance on the accuracy of Figure 3 of the WMAwater report to explain and justify some of the study results and findings. Yet, there is no explanation about the data used to produce this figure and how the '*pre to post dam estimation line'* has been developed. There

are several reasons why the inferences made from Figure 3 may be inaccurate and may significantly overestimate post-dams peak discharge at the Port Office, including:

  - The 1893 flood 'post-dam' discharge at the Port Office gauge is smaller than the equivalent 2011 discharge, although the 1893 'pre-dam' discharge is much larger than the equivalent 2011 discharge. The reason for this apparent inconsistency is not explained in the WMAwater report.
  - The January 2011 flood had two peaks with the first flood peak inflow to the Wivenhoe and Somerset dams of the order of 12,000 m^3/s, whereas the corresponding peak discharge at the Port Office gauge for the first flood was only of the order of 2,000 m^3/s, a more than 80% reduction. This reduction in peak discharge at the Port office for the first flood event is not represented in Figure 3.
  - The February 1999 flood was larger than the 1974 flood in the upper Brisbane River, but its impact on Brisbane was insignificant because this flood was fully mitigated by the dams (Seqwater, 2011). The peak flood level at the Port Office gauge was less than 1.7m AHD. The 1999 flood event is not represented in Figure 3.

- It is not clear how the ARI of the January 2011 flood or the 100 year ARI flood discharge for current (with dams) river conditions have been determined. The WMAwater report provides no analyses or justification for its results and findings on this issue. Further, the 100 year ARI peak flood discharge adopted for the lower Brisbane River for the current river conditions is not consistent with equivalent results for pre-dam conditions for the following reason. The WMAwater report has determined that the ARI of the January 2011 flood under current river conditions is 120 years. However, it has adopted a 100 year ARI flood discharge for the lower reaches of the river of 9,500 m^3/s, which is the same as the magnitude of the estimated January 2011 peak flood discharge at the Port Office gauge. The 100 year ARI discharge should be lower than the 120 year ARI discharge.

5 FINDINGS ON PREDICTED 100 YEAR ARI FLOOD PROFILE

It appears that there is an inconsistency in the predicted 100 year ARI flood profile. The adopted peak discharge for the January 2011 flood and the 100 year ARI flood (9,500 m^3/s) are identical. However, there is a significant difference in the predicted flood profiles for these two floods (see Figure 13 of the WMAwater report). The reason for this difference is not known and has not been explained in the WMAwater report.

The WMAwater report does not provide any details on the inflow boundary conditions (discharge hydrographs) or the downstream boundary condition (tide level) adopted to predict the 100 year ARI flood profile. Based on Figure 13 of the WMAwater report, it appears that the same downstream boundary condition has been adopted for both January 2011 and 100 year ARI Mike-11 model runs. If this is the case, the adopted downstream boundary condition may not be appropriate to predict the 100 year ARI flood profile.

6 CONCLUSION

In my opinion, the analyses presented in the WMAwater report are not sufficiently rigorous to accurately estimate the ARI of the January 2011 flood or estimate the 100 year ARI flood discharges or levels in the lower reaches of the Brisbane River, especially for current (with Wivenhoe and Somerset dams) river conditions. There are significant uncertainties in the FFA results presented in the WMAwater report, including potential errors in the 100 ARI discharge estimate. There are also some apparent inconsistencies in the estimation of the 100 year ARI flood profile. For these reasons, in my view, the findings of the WMAwater report should not be accepted until they are validated by more comprehensive hydrologic and hydraulic modelling studies. I understand that such studies are to commence in the near future.

Please do not hesitate to contact me if you have any queries.

For and on behalf of
WRM Water & Environment Pty Ltd

[redacted]

Dr Sharmil Markar ***BSc(Eng) PhD FIEAust CPEng RPEQ***
Principal Engineer

References:

Seqwater (2011) '*January 2011 Flood Event - Report on the operation of the Wivenhoe Dam and Somerset Dam*', Report prepared by Seqwater, March 2011.

SKM (1999) '*Brisbane River Flood Study (Draft)*', Report prepared by Sinclair Knight Merz for Brisbane City Council, June 1999.

WMAwater (2011) '*Brisbane River 2011 Flood Event – Flood Frequency Analysis, Final Report'*, Report prepared by WMAwater for the Queensland Flood Commission of Inquiry, September 2011.